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HOP CULTURE IN CALIFORNIA.

BY

DANIEL FLINT.

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U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF BOTANY,
Washington, D. C., February 6, 1900.

SIR: I transmit herewith the manuscript of an article on Hop Culture in California, prepared by Daniel Flint, a practical and successful hop grower of that State, and one of the pioneers in that branch of agricultural industry on the Pacific coast, and recommend the publication of the same as a Farmers' Bulletin. While it can not be said that among our agricultural industries the hop industry is relatively very important, or offers a very large field for future developments, it is believed that California possesses very favorable conditions for the extension of this industry, and that this article contains directions and suggestions which will prove useful to the hop growers of that section, both actual and prospective.

Respectfully,

FREDERICK V. COVILLE,
Botanist.

Hon. JAMES WILSON,
Secretary of Agriculture.

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HOP CULTURE IN CALIFORNIA.

INTRODUCTION.

The statements made in this bulletin apply particularly to hop culture in California, and to some extent they apply also to hop culture in Washington and Oregon. Brief reference is also made to the chief points in which the conditions in those States differ. In some respects methods of hop culture are the same the world over, but owing to peculiar characteristics of soil and climate a system which would work well in England, on the continent of Europe, or in New York State would not succeed on the Pacific coast.

So severe has become the competition in hop culture, as in all other branches of agricultural industry, that the producer to be successful must be ever on the alert to apply the best and most modern methods. The last five years have seen some of the best hop yards on the Pacific coast sold out under mortgage on account of unremunerative prices, unskillful production, and unbusinesslike methods. There is not a hop grower on this coast, unless it be one who has a large bank account which he can afford to reduce rapidly, who can stay in hop culture using the methods which were in vogue twenty-five or thirty years ago. Under the proper headings in the following pages are described the improved methods which alone insure success, and those which should be discarded are briefly referred to.

BOTANICAL FEATURES OF THE HOP PLANT.

There is but one botanical species of the hop (*Humulus lupulus*), but numerous varieties have been developed by cultivation. The hop is a climbing vine with harsh foliage and rough stems which twine from left to right with the sun. In a wild state the vines clamber up the stems of shrubs or over walls and fences. They frequently reach a length of 25 feet or more.

The hop is a perennial plant, the vines dying in autumn, and new ones springing up from the root in spring. It is dicœcious, the male and female flowers occurring on different plants. Hops can be propagated either from seed or roots; the latter are almost universally employed in practical culture; the former are useful as a means of developing new varieties. In some parts of Europe, notably the best hop-growing regions of Bohemia, seedless hops are raised. Great

efforts are made to prevent any male (staminate) plants from maturing, it being maintained that the presence of seeds in the hops detracts from the flavor of the particular kinds of beer made therefrom. In America, on the contrary, a small proportion of the plants put out in every yard are staminate, the presence of seeds in the hops being considered by the grower an advantage.

The female (pistillate) flowers of the hop plant are clustered in short axillary catkins. They are without petals. In maturing, the scales of the catkin increase much in size, and form a membranaceous cone or strobile. The ovary and the bases of these scales are covered with a yellowish, aromatic, resinous substance known as lupulin, consisting of minute grains, each of which is a lupulinic gland.

The strobile is the fruit of the hop plant, and, when gathered and cured in quantity, constitutes the hops of commerce. The virtue or essential principle of the hop resides in the lupulin. The amount of this is given by different authorities as from one-sixth to one-twelfth of the hops by weight. In the markets too much stress is often laid on the color of hops instead of on the quality and quantity of the lupulin, which is the important element to be considered by the brewer or the manufacturer. In California, quality is usually sacrificed to the production of quantity.

VARIETIES OF HOPS.

In New York State several varieties are cultivated, while in England and on the continent of Europe there are numerous varieties. But on the Pacific coast there is practically but one variety of hops grown, called the "Large gray American." There is a variety known as the "San Jose root," but it is destroyed wherever found. It is darker in color, has a smaller vine and more leaves, and is poorer in yield.

The variety commonly cultivated was brought from Vermont and propagated in Alameda, Alameda County, Cal., by Wilson and Daniel Flint, in the years 1855 and 1856. From there roots were taken to Sacramento in the year following and planted in yards, from which have come the original roots for nearly all the hops grown on the Pacific coast. The growers are so well satisfied with this variety that little effort is made to develop or introduce new varieties. A variety that would ripen a few days earlier might be cultivated with profit, as it would increase the length of the harvest season and enable the grower to harvest his crop with a smaller crew of pickers. As it is now, our hops must be gathered inside of three or four weeks to prevent them from turning red or rusting. New varieties may be produced by planting the seeds of the hop. Seeds accidentally scattered on the ground at picking time sprout and come up in great numbers, and these may be used as material for experiment in producing new varieties. It

is worthy of remark, however, that, regardless of the kinds planted, great variations in hops result from differences in soil, climate, and methods of culture. This is clearly shown by the fact that in California from roots having a common origin different growers in different localities are now producing green, medium, and golden hops.

WHERE GROWN AND YIELD PER ACRE.

The hop can be grown in nearly all parts of the world, but not at a profit. It thrives best on a deep, rich, moist soil, such as that found in the bottom lands along large streams, especially those which have overflowed and deposited sediment for hundreds of years.

In the United States, New York is the leading hop-producing State, followed by the Pacific coast States, Oregon, California, and Washington, in the order given. Small amounts are raised in Wisconsin and a few other States. Within the past eight years the production of New York has gradually fallen from about half the total for the country to about one-third.

The advantages of California in the production of the best and purest hops are acknowledged by all who have investigated the subject. The industry is confined to a few counties in the north central portion of the State, the principal hop-growing district lying near Sacramento.

Sacramento County.—The largest yield per acre, 2,500 to 4,000 pounds, is grown on the American River in the northern part of Sacramento County. The land here is composed of a rich sediment from 1 to 4 feet deep washed down, overflowed, and deposited as a result of surface mining from 1849 to 1855. This sediment is composed largely of decayed vegetable matter that had been collecting in the mountains for unknown ages. On the Sacramento River, in the western part of the county, a better quality of hops is grown, the yield being from 1,500 to 3,000 pounds per acre. The bottoms of the Consumnes River, in the southern part of the county, are coming to the front very fast with fine yellow quality and generous yield of hops. They are silky, smooth, even-yellow hops, the kind much sought after by buyers.

Yuba County.—On the Bear River, in this county, large quantities of hops are grown, and they are of fair quality. The land here also is composed of sediment from the washings of mining. The yield is from 1,500 to 2,000 pounds per acre. This county lies north of Sacramento.

San Joaquin County.—Along the Mokelumne River, in the northern part of the county, there is rich sediment land, and good crops are grown. Farther south, on the San Joaquin River, very few hops are grown, grazing and production of hay and cereals being the leading industries.

Yolo County.—In this county, which borders the west bank of the Sacramento River, the hop industry has developed considerably, but without any very striking features.

The second hop-growing district lies in the same latitude, but nearer the coast, and embraces parts of Sonoma, Mendocino, and Alameda counties.

Sonoma County.—At Santa Rosa, in the eastern part of the county, are grown the finest-colored hops produced in the State, but they are not supposed to possess any superior merit for brewing purposes. Hops are also grown along the Russian River, in the northern part of this county.

Mendocino County.—Farther up the Russian River, in this county, good hops are raised, the yield ranging from 1,200 to 2,000 pounds per acre.

Alameda County.—This county lies east of and borders on the Bay of San Francisco. Hops are grown in the central part of the county, the largest hop plantation in the State being at Pleasanton.

CLIMATIC CONDITIONS.

In California climatic conditions are very favorable to hop culture. From the 1st of May till the 1st of October there is little rain. In some regions heavy rains in the summer and early fall cause a disastrous development of mildew and lice, which can be kept in check only by spraying, an expensive and troublesome operation. Among the advantages enjoyed by California, so far, is an entire freedom from such pests.

In selecting a locality for starting in hop culture, it is best to choose one where irrigation is unnecessary, except in excessively dry years. It is expensive to irrigate; and, unless the irrigated ground is worked, in a few days it will become hard and crack open, and the results will be bad. Ground, to be successfully irrigated, should be made as level as possible before planting out the roots. If the ground is quite sloping a system of checks can be used. Water should not be allowed to stand long, as the hop can not stand a wet subsoil.

BEGINNING OF THE INDUSTRY IN CALIFORNIA.

Hop growing in California began in 1855 in Alameda County. Prior to this the only hops used on the Pacific coast were brought "around the Horn." It was thought necessary to inclose them in sealed tin cans in order to preserve their strength. This made them very expensive. At that time they were used mostly for yeast and medical purposes, the great development of the brewing business having hardly begun. The first hops grown in California were cured on blankets and sheets spread on frames, and pressed into cotton sacks,

holding about 100 pounds each. The first two sacks were sold to brewers of Sacramento. The brewers were accustomed to using the hops which came around the Horn, whose age was unknown and whose color and strength were nearly gone. When they first tried fresh, strong California hops they used the same quantity, with the result that the beer was too bitter for use. Consequently they began to reduce the quantity used for a brew and to mix them with the old imported hops.

METHODS OF CULTURE.

A farmer who wishes to make a success of hop culture should select the best and moistest soil he has, without a wet subsoil. This kind of soil will prove the most productive and easiest to cultivate. Sandy loams are preferred by experienced hop growers. Clay, adobe, and alkali land should be avoided.

Preparing the ground.—In plowing for a hopyard, do not use too large a plow, as a medium-sized one will do better. Plow both ways and make the land mellow by harrowing after both plowings. It is well to use a subsoil plow and loosen the soil as deep as possible, but the subsoil should not be turned up to the surface. The hop plant is a great feeder, its roots reaching far downward and outward.

The rows.—In the United States the customary width apart of rows is 7 to 8 feet, the former being the usual width on the Pacific coast. If they are closer the hops will bunch up, the sun can not get at them, and they will look immature and faded out for want of sunshine.

A sled is used in marking out the rows. The yard should be cross-marked at right angles. Straight rows are very desirable and a sign of good farming. To secure them, run the first row by stakes marked with white paper; then let one runner of the sled return each time in the last row made; or, if that is not fast enough, an outrigger can be placed on the sled to follow in the last row marked. If the yard is fenced, plenty of room should be left to turn the team in cultivating.

The roots or sets.—The hop plant sends out near the surface of the ground runners or layers extending several feet without diminishing in size. These have numerous eyes or buds. These runners are removed and cut into pieces 6 to 8 inches long, containing two or more eyes, and these are known in hop culture as "roots."

In putting out a new yard the best possible roots should be secured. Many growers think it better to secure roots from another district. This is a common practice in the best hop-growing districts in Bohemia.

Pruning.—This operation can be performed in the fall after the first rain, but on this coast it is usually done in January or February. Most growers turn the soil away from the hills by running a plow on each side of the row and as close as may be without injuring the plants. Some large growers use a disc plow with four or five horses,

running close up to the hills on both sides of the row. Then, with the hoe blade of a mattock or a large potato hook, the soil is entirely removed from around the plants, exposing their condition. A sharp steel knife is used to cut away all surplus roots or runners. Also 1 or 2 inches of the crown may be cut off where the eyes are not properly developed. Four to eight buds are enough to leave for the development of vines. If any plants are found to be rotten or unhealthy, they should be removed and new sets should be put in their places. After pruning, take a hoe and draw up the nice mellow soil so as to cover the hills about 2 inches deep, forming a slight mound.

Planting.—In California planting is usually done in January and February. With a dibble, put two or three roots in a hill where the markings cross, leaving their tops level with the surface of the ground, 6 to 8 inches apart. In every tenth hill of every tenth row put male or staminate plants so that they will occupy every one-hundredth hill. With a hoe draw up the mellow earth so as to cover the tops of the roots 2 or 3 inches deep, making a small hill. On very moist ground a lighter covering will answer. In fact, some growers leave the hills quite bare.

Replanting.—As already stated, the hop plant is perennial, the root sending up a new crop of vines every spring for an indefinite period. But after a number of years the crowns become too large and woody, the vines start later in the spring and grow less vigorously, and there is a decline in the yield of hops. Hence it is considered best to renew the roots every ten or twelve years. In doing this, the ground should be thoroughly torn up with a large plow and a strong team, and prepared as for a new field. It is better to plant the new hills halfway between the places where the old hills stood.

If single hills in a yard become weak or unhealthy, they should be dug out and new roots put in their places.

In California a crop is harvested the first year often amounting to 1,500 pounds or more per acre, and the plants are at their best the second year.

Cultivation.—The object of cultivation is to keep the ground mellow and retentive of moisture, and to keep down weeds. As the hop has a mass of fibrous roots reaching out in every direction near the surface, it is bad policy to cultivate very deeply during the growing season. In ordinary seasons, in the vicinity of Sacramento, cultivation can go on until the 1st to the 10th of July. The plow and harrow are indispensable tools for nearly all purposes in hop culture. Never plow without following soon after with the harrow, unless you have wet land and wish to dry it out. The cultivator and disk plow are useful instruments in a hopyard. The plants should not be hilled up much, but the ground should be kept nearly level. In cultivating, steady horses

should be used, and the men should be careful; the whiffletrees used should be short, and there should be no projecting buckles or straps to catch the vines. Until the hops are well armed out, a pair of medium-sized horses may be used to plow out the centers, while the cultivation nearer the rows may be done with one horse.

SYSTEMS OF TRAINING.

In California hop poles have been almost dispensed with on account of their scarcity and short life and the labor and expense of handling them. The substitution of the wire trellis for the old-fashioned pole system has reduced the cost of hop production more than any other improvement. In Washington and Oregon, where poles are easily secured at small expense, they are still used to some extent.

In California two forms of wire trellis are used—the high and low—the former being the most modern and the most generally employed.

The high wire trellis.—This system may be briefly described as follows: Rows of poles are set at considerable distances apart across the yard each way at right angles; wires are stretched and fastened to the tops of the poles; strings are tied to these wires and drop down to the ground, serving as supports for the vines.

The posts are of redwood or cedar, 4 to 6 inches in diameter, and 20 feet long. The outside rows of posts should be 6 by 6 inches. Posts 4 by 6 or 4 by 4 are sometimes used for inside supports. These are set from 2 to 3 feet in the ground. The outside posts should slant outward at an angle of 30 degrees from the perpendicular. Opposite each of these, at a distance of about 20 feet, an anchor 6 by 6 inches in size and 4 feet long should be buried 4 feet in the ground.

All posts, except the outside row on each end of the yard, are set 35 or 42 feet apart—that is, a row of poles in every fifth or sixth row of hops. For the principal or supporting wires No. 4 black cable wire is used. These are stretched across the field the shortest way and fastened on the top of each post in the row with a staple. Each wire should be drawn taut and fastened to the anchor at each end. For the transverse or trellis wires No. 6 black wire may be used. These wires should be passed over the supporting wires at right angles and fastened where they cross with pieces of small wire or twine. These wires should be strung only 7 feet apart, or one for each row of hops. At the ends it is customary to set a post, sloping outward and anchored as already described, at the end of every other row. The alternate wires can either be run down to the ground and anchored without the support of posts, or they can be "forked" and fastened to the post on each side, thus leaving space for teams and wagons to pass in and out.

Fields should not be made too large, and great care should be exercised to see that no weak spot is left in the trellis, for if one post breaks,

the whole field is liable to go down. A close watch should be kept and, in case of a heavy crop, some of the outside posts should be propped.

Low trellis.—A common form of low trellis is made by setting up at each hill a stake 7 to 9 feet long with wires or strings crossing from post to post at right angles over the tops of the stakes, to serve as supports for the vines after they reach the tops of the stakes.

When the low trellises now in use in California give out there will be few if any more of the kind put up, for several reasons: (1) The hops bunch up and grow too much in the shade; the sun does not have a good chance at them, and perhaps one-third of the crop will be immature and look bleached out. (2) The hops can be cultivated for a short time only, on account of the drooping arms. Teams can not pass between the rows to scatter manure or haul off the vines and hops. (3) The Chinese and Japanese who usually take contracts to grow hops charge more per acre for low trellis than for high. Pickers also charge more for gathering the hops. (4) When the vine is once placed on the string of the high trellis little more trouble is experienced, unless a strong wind occurs; but in case of the low trellis, as soon as the vines reach the tops of the stakes they refuse to go on the horizontal supports and have to be put around the strings or wires by hand, and this operation has to be repeated every few days till the growing season closes.

TYING UP THE VINES.

The operation of tying up the vines is usually performed between the 1st and the 20th of May. Cotton cord is used in making supports for the vines. A piece of 8-ply cord 15 feet long is spliced to a piece of 20-ply, 4 feet long, the latter forming the upper end, which is tied to the wire. While the vine is climbing up, the smaller cord is sufficient to bear its weight, and when it reaches the stronger cord near the top there is little danger of its breaking. Manila and Japanese twine have been used, but have proven failures. Should strong winds from one quarter prevail for two or three days and the vine be blown away from the string it may possibly need to be replaced; however, it will generally resume its position without assistance when the wind dies away.

The hop vine twines from left to right around its support, and this movement produces a twist in the stem from right to left. The vine is six-sided and has little sharp hooks on each of its six corners, with which it holds on to its support. In the latter part of the cultivating season the men frequently wear masks of wire to keep the vines from scratching their faces.

In tying up the vines four of the most thrifty and longest-jointed vines in each hill are selected, and the rest are destroyed by pulling

up or cutting off. If all the vines in the hill seem inferior, all may be cut off, and in a short time better ones will appear. Sometimes, however, a vine which appears small in the start will, when it reaches a length of 4 or 5 feet, thicken and become a fine, vigorous vine. There are differing opinions as to the number of vines which should be preserved and trained up for bearing hops. The following sums up the results of the writer's experience: The average for all purposes and all soils should be: Hills, 7 feet apart each way, two strings to each hill, and two vines around each string.

To put up these strings, a platform with a railing around the top is mounted on a wagon. On this the men stand, the elevation being such that their heads just clear the wires. The strings are made ready in advance. The wagon is driven parallel with the transverse or trellis wires. With one man to drive and six on the platform, the strings can be put on three wires at once about as fast as the team can walk. Three men follow, tying the lower ends of the strings to pegs driven in the ground at the hills. New strings must be procured every year, as it would cost more than the string is worth to disentangle it from the twisted vine.

When the vine is about 2 feet long it is wound around the string two or three times, after which it will take care of itself if not disturbed.

HARVESTING.

Hop picking.—In California the harvesting season begins about August 20; in Oregon and Washington a little later. Picking the hops should be commenced as early as possible, should be prosecuted with all speed, and completed in four weeks, else the hops will turn red and dry on the vines, and the pickers will not want to gather them except at prohibitive prices.

On account of varying soil conditions, some parts of the yard will always ripen earlier than others. The pickers should therefore be moved around from place to place, gathering the ripest and leaving the greenest for the last.

On this coast most of the picking is done by the hundredweight of green hops. This seems a fairer way than by the box, and it is in line with the general market custom here of measuring by the hundredweight instead of by the bushel or other measure of capacity.

The picker is furnished with a knife, a sack, and, to receive the hops, a basket, barrel, box, or a cloth spread on the ground, the last being preferred by the Indians. Each picker takes a row of hops. With the knife the vine is cut 2 or 3 feet from the ground and is pulled violently parallel with the wire to which the string is tied at the top. This will break the string close up to the wire, and string and vine will come down. Then the picking proper begins, and here come in

the skill and dexterity of movement if the picker is to make good wages. The object is to get the hops without the leaves. Small leaves the size of the thumb nail or a little larger are not noticed, but larger ones show green in color when dried and lower the value of the product. Vines should not be cut faster than wanted for picking, as they wilt very quickly, making the hop that much harder to pick off. Hops should not be pressed down in the sack or basket, but should lie as light and loose as possible, for two reasons: First, a green hop that is pressed nearly flat will not let the heat pass through it as readily as one in its natural, open state; second, a hop that has been pressed in a box or sack will, if left there four to six hours, begin to heat and turn black, and sulphur will not bleach it out.

Each picker or company (where several work together) has a number which appears on the sack used and is entered in a book. By this means, when the sacks are emptied, any unclean work can be traced back to the picker, whose pay will be reduced accordingly. At noon, and again at 6 in the evening, the hops are put in burlap sacks holding from 50 to 90 pounds, which are then carried to the kiln, weighed, and hoisted, by means of a swinging crane or elevator run by horsepower, to a platform by the drying kiln, and on a level with the drying floor.

The pickers.—In California we are cosmopolitan in the matter of help. A few years ago, before the exclusion act went into effect, Chinese were mostly employed as pickers. Now we have Chinese, Japanese, Indians, and whites, the last being most numerous. The Chinese are the fastest pickers, but do the most unclean work; the Indians are the slowest and cleanest pickers; the Japanese pick well, and are the least troublesome; the whites pick well but slowly. Hop picking has become more popular with the whites in recent years. They come with their camp wagons, chickens, dogs, cats, and cows. The butcher, the baker, and the grocery man come around every day and furnish such things as are needed by the pickers, who camp near the yards. No charge is made for wood, water, cabins, tents, or horse pasture. As some of the pickers come without means, part of their wages is paid as fast as due to all who wish, but no settlement is made till the harvest is done, except in case of some picker who is obliged to leave. It is a good business method to have the head of each picking party sign a contract, stating the price and the conditions under which the work is to be done.

A good picker will gather from 150 to 200 pounds of green hops in a day.

CURING HOPS.

The kiln.—Hops are dried immediately after picking by spreading them on an elevated floor of slats covered with a carpet of burlaps,

and heating the air beneath so that it rises through the hops, carrying off the moisture. The structures in which hops are dried are known as kilns, and are of many kinds. In this State great progress has been made in perfecting the hop kilns and presses. Each grower seems to have some different idea, and all are striving for utility combined with economy.

The essential features of a hop kiln are as follows (fig. 1): The building is made of boards and usually lathed and plastered; is from 16 to 30 feet square, the height to the plate being 20 to 24 feet; the roof runs up with a steep slant from each of the four sides nearly to a point at the top, where is located the opening, 3 feet square, or a little more, for the air to pass out. About 4 feet below the plate and 16 to 20 feet from the ground is placed the drying floor, made of slats 1 to 2 inches wide, with spaces between of the same width. The space below this constitutes the stove room, in which the air is heated by means of a large stove or furnace with pipes extending from it to a flue at the side in such fashion as to expose to the air a large extent of surface. At the sides near the ground are openings in the walls to allow free entrance of the air from the outside.

From the typical kiln described above, there are many variations in use in the hop-growing districts of the world. Sometimes the kiln is built of brick, round in shape, with a conical roof. Often instead of being square it has one dimension greater than the other. In some the roof slants up nearly to a point at the top, on which rests a cowl to keep out rain, fitted with a vane so as to turn with the wind. In others the roof ends in a perpendicular shaft 12 to 15 feet high, with the ventilating shutter hinged near the top so as to be opened or shut by means of ropes and pulleys.

The latest development on this coast is the double-hopper kiln, with the cooling or storage room located about 200 feet away as a sure precaution against fire. In a kiln of this style the stove is placed in the center of the stove room. Resting on a brick foundation near the top of the stove is the lower hopper, its four sides slanting outward as they ascend so as to rest against the four walls of the building just beneath the drying floor. The upper part of the building from the plate to the ventilator constitutes the upper or inverted hopper. All the draft has to come through the lower end of the lower hopper, passing close to the stove.

There are serious objections to the introduction of this lower hopper. It increases the danger of fire, as the woodwork at the bottom comes too near the intense heat of the stove; also the dust falling down from the drying floor lodges on the sloping sides of the hopper, where it easily ignites. Nearly all the kilns of this style in use in California have, at one time or another, caught fire, and many of them have been

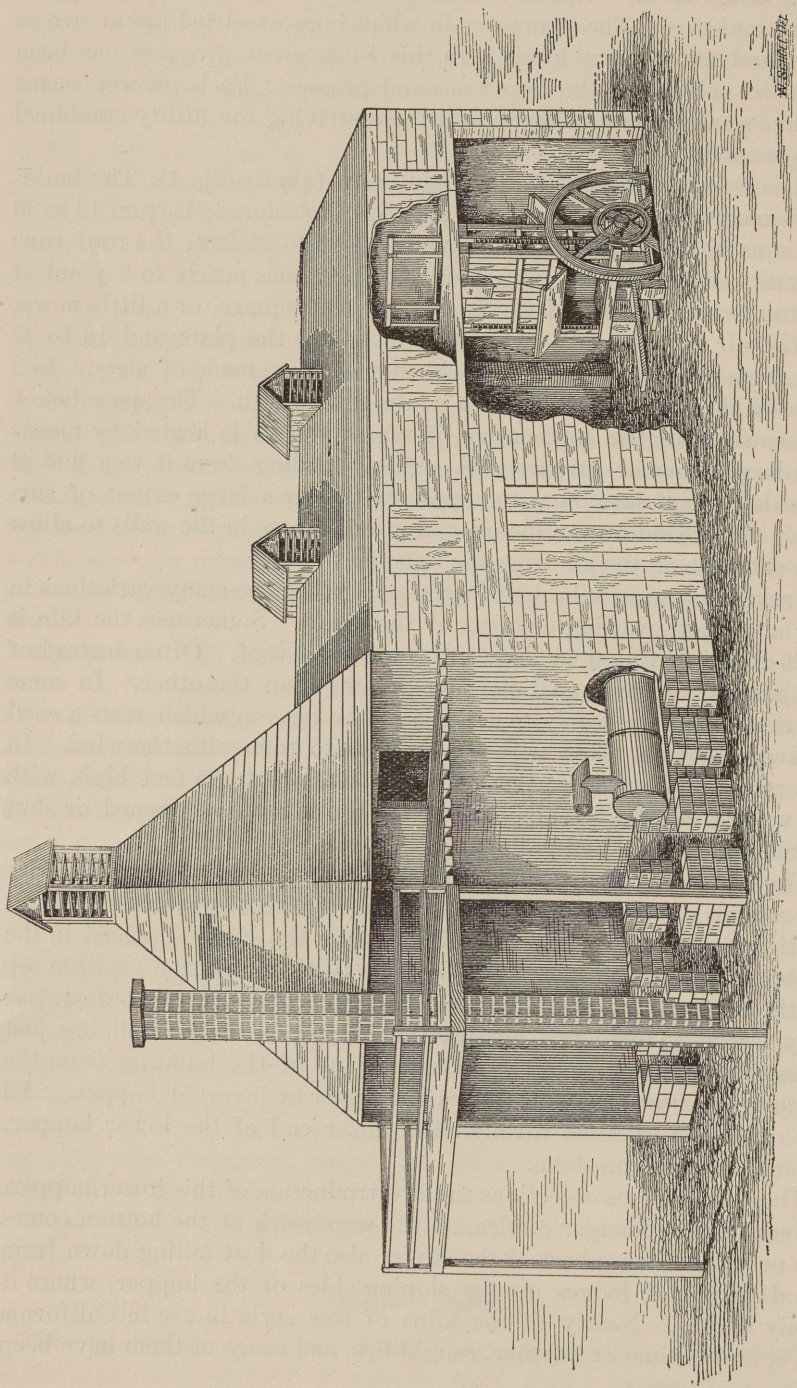

FIG. 1.—Hop kiln with cooling and storage rooms adjoining.

destroyed. Another objection to this kiln is that the space within the hopper is too limited for the proper amount of hot-air pipe.

The elevation of the drying floor should be not less than 20 feet, as a precaution against scorching the hops. In making a kiln the prime object is to so construct it as to secure a good draft, the air coming in cool at the bottom, becoming heated in the stove room, passing through the layer of hops spread out on the drying floor, and passing out at the top laden with moisture. To increase this draft rotary fans have been experimented with. Some have been placed in the top to draw up the hot air by suction. Others have been placed under the hop floor to force the hot air upward. Thus far the fan system has not been an entire success, but great progress in the economy and dispatch of hop drying may be looked for in the future.

A kiln for a 20-acre yard should not be less than 20 by 30 feet, and the cooling room should be three or four times as large. The cost of such a kiln is about as follows: Stove $100, pipe $75, press $300, and $1,500 for the building, making about $2,000 in all.

Many kinds of stoves are used in hop drying. In California very good stoves have been made from old locomotive boilers by cutting a large door in the end, and putting two or three belts of angle iron around the middle to keep the boiler from collapsing when hot. A slot 8 inches wide and 3 feet long is cut through the center fitted with grate bars to let the ashes fall through, and a circular hole in the top for the stovepipe.

The heating pipes should be about 12 inches in diameter, though they vary in different kilns from 7 to 14 inches. Rising from the stove there should be a joint of pipe T-shaped, from the arms of which the pipes run in opposite directions around the room, 2 to 3 feet from the wall and about 7 feet from the ground, gradually rising and entering the chimney on the opposite side of the stove room, the whole forming almost a hollow square. There are many variations from this typical arrangement of the pipes. In the double-hopper kiln the pipes rise in a sort of irregular expanding spiral form. These pipes are suspended by wires fastened to the girders of the drying floor, or held up by supports resting on the ground. The heating stove is sometimes entirely built over with brick and mortar to reduce the danger of fire. If this is not done, a large piece of sheet iron is often suspended over the stove as a further precaution against fire; and to avoid smoking the hops the pipes should be swept free of the dust which sifts down from the drying floor.

There must be plenty of holes close to the ground to let the cold air in, as the upward motion of the air must be as rapid, free, and continuous as possible. These draft holes should be fitted with shutters. The kiln is commonly built on a brick foundation as high as 3 or 4

feet from the ground. In this foundation the apertures for ventilation are provided for.

On one side of the kiln a platform is erected on a level with the drying floor. To this platform the green hops are elevated and from it they are passed in through a door. Various means are employed for elevating the hops to the drying floor. In some cases inclined driveways are erected up which teams with loaded wagons are driven. More commonly the hops are drawn up from the ground by means of an elevator or a swinging crane.

Drying the hops.—The slat floor of the curing room rests on strong joists or girders. Over this floor to receive the layer of hops is spread a kiln cloth or carpet, usually of flax or hemp, made of small hard-twisted threads loosely woven so as to allow the air to pass through freely. A good fire should be kept up for several hours to thoroughly warm up and dry out the kiln before putting on the first flooring of hops.

The hops should be spread out on the drying floor as evenly and lightly as possible, and from 18 to 24 inches deep. As to the height to which the temperature should be raised and the number of hours necessary for properly curing a flooring of hops, there are many differences in opinion and practice. In California it is customary to dry a flooring of hops every twelve hours, using a sufficiently high temperature to do the work in that time. A fresh batch of hops is laid on the drying floor at noon and another at midnight. To dry hops successfully requires experience and judgment. A good dryer examines the hops every few hours to note how the drying progresses, and see whether he is firing too much or too little. The more rapidly the heat can be drawn through the hops the better, quicker, and more evenly they will dry. If the hot air should remain stationary for a short time the hops would be scorched. Some use a thermometer, keeping the temperature between 125° and 140° Fahrenheit, but nothing can take the place of skill and judgment in the dryer.

If the fire has been properly kept up, by 9 or 10 o'clock the hops around the side of the kiln will begin to rattle. It is then time to turn them. The top hops are the slowest to dry and are constantly pressing down on the dryer ones beneath, making it harder for the air to pass through. For these reasons the hops should be turned or stirred. This may be done with a wooden barley fork, or it may be done by walking through them, and thus plowing them up with the feet. In case the latter method is employed, the feet should be dragged along the floor so as to avoid stepping on the hops.

Hops should not be kept in the kiln until every stem or core is dried out. If they are, some will get too dry and powder up. A small percentage of the cores may be left green, as the heat of the mass of hops

when removed from the kiln will be sufficient to drive off what moisture may remain.

The doors of the kiln above and below should be thrown open half an hour before the hops are to be taken off, in order that they may cool off somewhat, as they are very brittle when hot. It is dangerous to take hops off the kiln while they are slack or underdried. They are likely to heat, and may come to have a smell like that of tobacco, which is hard to get rid of. Slack hops should be turned several times in the cooling rooms before baling.

On an average, it takes about three-fourths of a cord of willow wood to dry a thousand pounds of hops, dry weight. Owing to the gradual ripening of the crop, it takes almost as much again heat to dry a flooring at the beginning of the curing season as it does at the end. The dryer must use great caution or he will scorch the last picking. Though ever so fine a hop may be grown, unless it is properly picked and cured the profit of the season's work will be lost. But a small percentage of hop growers can be classed as first-class hop dryers. To succeed at it a person should take pride in the business, possess industry and keen judgment, and be always willing to learn.

Bleaching.—The color of the hops seems to depend largely on climate and soil. In Sonoma County the golden color seems to result from the bleaching effect of fogs and heavy dews. Here the hops will also remain longer on the vines without turning red than they will in a less humid climate. The golden color of the hops grown in and around Sacramento is attributed to the fact that they are grown on sediment land having a clay or adobe subsoil. The color of the hops is even affected by the thick growth of morning-glory among them, which causes them to be more yellow.

Some buyers want light green and others red hops; but the principal demand is for yellow or straw-colored hops. This has led to the custom of bleaching or sulphuring. To produce a uniform straw or golden color the process of bleaching with the fumes of burning sulphur is carried on in connection with the curing of the hops. About 1 pound of sulphur is used for each 100 pounds of green hops. It is put in two or three iron pans, which are placed on brick or iron supports about 2 feet from the ground, and set burning by means of a hot iron or a few burning coals soon after the hops are put on the kiln. If the hops are green or damp, sulphur of the crude or rolled kind should be applied, or it will have but little effect.

Sulphur is used for three reasons: First, to bleach the hops; second, to accelerate the drying; third, for its preservative effect on the product.

Cooling.—The building used for cooling, storage, and baling is most commonly built to adjoin the drying kiln, the floor of the cooling

room being 3 or 4 feet lower than the drying floor. When the drying is completed, the hops are thrown through a door in the separating wall, falling on the floor of the cooling room, where they are moved to cooling bins by means of a small car. When the hops come off the kiln they are dryer than the atmosphere, and have to go through a sweating process.

In some cases the building used for cooling, baling, etc., is located at a considerable distance from the kiln as an extra precaution against fire. In such cases the hops are usually moved from the kiln to the cooling room by means of a car running on an elevated track, or by means of a large bag or swinging box running on a rope or wire cable. The room below the cooling room is used for baling and storage.

BALING.

When the process of curing the hops is completed, they are prepared for shipment by pressing into bales. The press in general use on the Pacific coast produces a bale 20 inches square at the ends and 5 feet long, weighing from 175 to 250 pounds. It has a capacity of 40 to 75 bales per day. The box is 20 inches wide, 5 feet long, and 8 to 10 feet deep, and is surrounded by a strong framework of scantlings. The baler is placed beneath the cooling room, a hole being cut in the floor as large as the mouth of the box, down which the hops are shoveled till the box is filled. Underneath the box, running lengthwise of the baler, is a 3-inch steel rod extending a short distance beyond the box at each end. On one end of this rod is fastened a wheel 10 feet in diameter through which the power of a team of horses is applied. On the rod are two 8-inch pinion wheels placed so as to just clear the ends of the box. These work into racks 4 inches wide, bolted firmly to two 4 by 4-inch 16-foot scantlings which work up and down. At the top these scantlings are hinged to the ends of a 4 by 12-inch crosspiece about 7 feet long. From this crosspiece drop two 4 by 4-inch pieces, 8 feet long, to the bottom of which is firmly fastened the follower which fits into the box and, as the power is applied by means of the rack and pinion, presses down the hops. (See fig. 2.)

The lower part of each side of the box consists of a door hinged on its upper edge to one of the heavy horizontal pieces of the outer frame, and opening upward and outward. When ready for operations, a piece of baling cloth is cut of proper size and placed in the bottom of the box. The doors of the baler are then closed and the box is filled. The hops are moved to the baler in a sort of small car, or a two-wheeled barrow, and about three times full make a bale. While filling the box, the hops are packed somewhat with a pole to the end of which is fastened a short piece of scantling. When the box is filled another piece of cloth is spread over the hops, the follower is swung into position, and the horses started. Four turns of the wheel bring

the follower down as far as it should go. The doors are then opened and the edges of the upper and lower pieces of cloth brought together and sewed with a lock stitch. The bale is then removed from the press.

The power used in operating the press is transmitted by means of a heavy rope which runs over the large 10-foot wheel. Another rope runs over a similar wheel 3½ feet in diameter fastened on the outside of the large wheel. These ropes are arranged so as to work opposite to each other, one unwinding as the other winds up. The one running

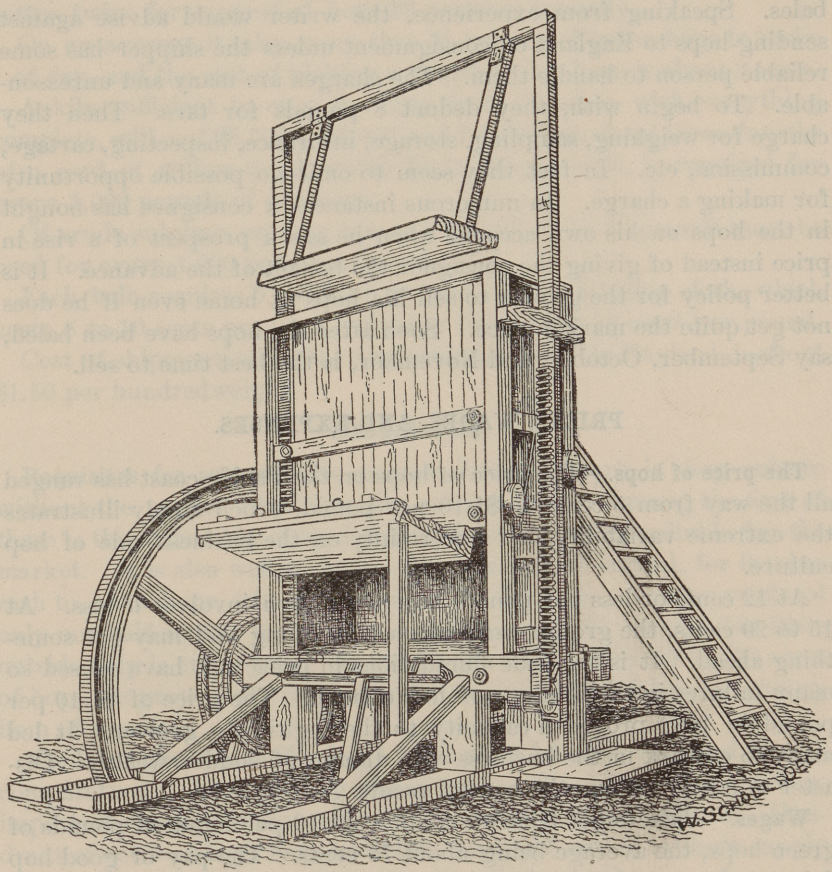

FIG. 2.—The hop press or baler.

on the outside wheel is used to raise the follower after the bale is pressed.

The bales of hops should be stored in a cool, dark place. As the aroma is continually passing off, the bales should be as little exposed to drafts as possible. It is well to place on each bale by means of a stencil a small private mark, but the weight should not be put on, as it is liable to change with the weather, increasing in damp and decreasing in dry weather.

MARKETING.

The usual weight for a bale is 190 to 200 pounds. When sales are made a deduction of 5 pounds from each bale is made for "tare." Sales are usually made by sample.

In order to introduce California hops into England, the writer a few years ago shipped consignments to houses which were reputed to be reliable. For a time the results were satisfactory. But two of the houses went into bankruptcy and he failed to get returns for some 200 bales. Speaking from experience, the writer would advise against sending hops to England on consignment unless the shipper has some reliable person to handle them. The charges are many and unreasonable. To begin with, they deduct 8 pounds for tare. Then they charge for weighing, sampling, storage, insurance, inspecting, cartage, commission, etc. In fact they seem to omit no possible opportunity for making a charge. In numerous instances a consignee has bought in the hops on his own account when he saw a prospect of a rise in price instead of giving the consignor the benefit of the advance. It is better policy for the grower to sell his hops at home even if he does not get quite the market price. Soon after the hops have been baled, say September, October, and November, is the best time to sell.

PRICES, WAGES, AND EXPENSES.

The price of hops.—The price of hops on the Pacific coast has ranged all the way from 5 cents to $1.10 per pound, which amply illustrates the extreme variability and uncertainty on the business side of hop culture.

At 12 cents or less per pound, hop production involves a loss. At 15 to 20 cents, the grower can make a fair living and may get something ahead. It is the wide fluctuations in price that have caused so many failures in the business of hop culture. The price of $1.10 per pound in 1882 proved a calamity to the legitimate grower. It led many to embark in the business with dreams of sudden wealth. Disaster to nearly all was the natural result.

Wages.—Pickers get from 60 cents to $1.10 per hundred pounds of green hops, the average being about 75 cents. The pay of good hop driers is $2.50 to $5 per day and board. That of helpers, where they assist in taking off and putting on the hops in the night, is $1.25 per day and board. Field foremen get $1.50 to $2 per day and board. When contracts are made for growing hops (hand work alone), ready for picking, the price is $10 to $12 per acre. When the contract is for all work, including use of team in cultivating, the price is $14 or $15 per acre, owner to furnish teams and tools and make repairs, and the money to be advanced in equal monthly payments from February 1 to September 1.

In two instances in the writer's experience careful accounts have been kept to ascertain the actual cost of hop production. In the first, the picking, curing, and baling of 64 acres cost $2,200; in the second, the same operations on 40 acres cost $1,500, an average of about $35 per acre.

Expenses.—For planting an acre, 2,000 roots will cost $20, and the expense of planting them is $2.

The high wire trellis will cost from $80 to $90 per acre, and the cotton twine for support of hops $3 per acre annually.

On an average it takes more than 3½ pounds of green hops to make 1 of dry, and the cost of picking a pound of dry hops is about 3 cents.

A kiln sufficient to cure the crop from 50 acres, with everything complete, will cost $3,500 to $4,000, and for drying, about three-fourths of a cord of willow wood, worth $4 to $6 per cord, is required for every 1,000 pounds of dry hops.

Of crude sulphur, costing 2 cents a pound, 30 to 40 pounds must be used for every 1,000 pounds of dry hops.

Each bale requires 5 yards of 24-ounce, 44-inch baling cloth, which costs 8 to 10 cents per yard. Sewing twine costs 32 cents per pound.

Cost of shipment, when the product is marketed in England, is about $1.50 per hundredweight.

CONCLUSION.

Requisites for success.—No person should embark in hop culture without the proper requisites for success in it. Among the first of these is the ownership of land that will produce hops suitable for the market. It is also well to have a fair amount of capital, for it takes cash to grow hops. In Germany, where there are so many yards of only one-half acre to three acres, expenses are light because but little outside help is employed. On the Pacific coast, where 10 to 300 acres of hops are grown by a single person or firm, hired labor is a heavy item of expense.

The labor question.—The large number of laborers required for the comparatively short picking season makes the labor supply a very important element in the successful prosecution of hop culture. Hundreds of acres of hops have been left unpicked owing to short supply of pickers. General prosperity in other lines of industry only aggravates the difficulty by giving permanent employment to the laborers. There is one remedy which may be safely recommended: Everything possible should be done to make hop picking respectable and popular so that white families who are in good circumstances will engage in it.

There is plenty of suitable land on the Pacific coast alone to grow all the hops consumed in the United States and leave a large surplus for export. Cost of transportation is one of the drawbacks at present, but improvement in this direction is to be expected in the normal course of trade development.

SOME HOP STATISTICS.

The following statement was prepared by the Division of Statistics, United States Department of Agriculture:

HOP PRODUCTION IN THE UNITED STATES.

The latest official information as to the acreage, yield, and value of the hop crop of this country is that of the national census of 1890. Census Bulletin No. 143 gives the facts then obtained for 1889 and 1890. From it the following table is arranged, giving the figures separately for the few hop-producing States and the aggregate for the whole country in 1889:

Acreage, yield, and value of hops in the United States in 1889.

States.	Acres.	Bales.	Value.
New York	36,670	111,461	$2,210,137
Washington	5,113	46,185	841,206
California	3,974	36,374	605,842
Oregon	3,130	20,076	322,700
Wisconsin	967	2,381	51,983
Other States	358	1,141	27,829
Total	50,212	217,618	4,059,697

Acreage, yield, and value of hops in the United States in 1890.

States.	Acres.	Bales.	Value.
New York	35,552	99,229	$6,068,163
Washington	5,282	49,348	2,284,955
California	3,796	31,761	1,521,847
Oregon	3,223	21,174	1,047,224
Wisconsin	871	2,556	142,198
Other States	238	780	41,037
Total	48,962	204,848	11,105,424

The following tables show the estimated hop production of the Pacific coast States for ten years, and of the United States for eleven years, ending with 1899. These tables are made up principally of figures published in the agricultural and trade journals whose estimates are believed to be most nearly correct. The figures for 1895–1899, inclusive, appear in the Yearbook of the Department of Agriculture for 1899. Wisconsin disappears from separate mention since the census, and in estimates no account appears to be taken of the production of any but the States herein prominent, as it is comparatively insignificant. All amounts of hops herein given are in bales of 180 pounds.

Estimated hop production on the Pacific coast, 1890–1898.

Year.	California.	Oregon.	Washington.	Total.
	Bales.	*Bales.*	*Bales.*	*Bales.*
1899	64,000	85,000	33,000	182,000
1898	44,500	71,250	36,200	151,950
1897	45,000	75,000	32,000	152,000
1896	35,000	56,000	12,000	103,000
1895	52,000	99,500	28,800	180,300
1894	67,500	63,000	15,000	145,500
1893	51,000	.....	.....	.....
1892	39,000	.....	.....	.....
1891	36,000	.....	.....	.....
1890	28,000	.....	.....	.....

Estimated hop production of the United States, 1889–1899.

Crop.	Pacific coast.	New York.	Total
	Bales.	*Bales.*	*Bales.*
1899	182,000	58,000	240,000
1898	151,950	65,000	216,950
1897	152,000	75,000	227,000
1896	103,000	75,000	178,000
1895	180,300	110,000	290,300
1894	179,500	140,000	319,500
1893	143,000	125,000	268,000
1892	105,000	118,000	223,000
1891	94,000	114,000	208,000
1890	105,619	99,229	204,848
1889	106,157	111,461	217,618
Total 11 years	1,502,526	1,090,690	2,594,216

EXPORTS AND IMPORTS.

The exportation of hops for the last five fiscal years, as shown by the reports of the Bureau of Statistics of the Treasury Department, was as follows, with the average export price per pound, viz:

Exports of hops from the United States for the years 1894–1898.

Years.	Bales.	Value.	Price per pound.
			Cents.
1898	95,343	$2,642,779	15.4
1897	63,479	1,304,183	11.4
1896	93,140	1,478,919	8.8
1895	97,352	1,872,597	10.7
1894	97,072	3,844,232	22.0

The importations for the same period were as follows, with average prices, as shown by the official reports above named:

Imports of hops into the United States for the years 1894–1898.

Years.	Bales.	Value.	Price per pound.
			Cents.
1898	13,200	$648,155	27.3
1897	16,766	629,987	20.9
1896	15,400	600,419	21.7
1895	17,409	599,744	19.1
1894	4,600	484,415	58.5

A comparison of these tables shows the excess of exports over imports during the years named and the excess of import over export prices.

Excess of exports over imports and excess of import price over export price for the years 1894–1898.

Years.	Bales.	Value.	Price per pound.
			Cents.
1898	82,143	$994,624	11.9
1897	46,713	674,196	9.5
1896	77,740	878,500	12.9
1895	79,943	1,272,853	8.4
1894	92,472	3,359,817	36.5

The net exportation shown in the last table, deducted from the total production for the same years, as shown in the table of annual production for ten years, gives the figures of home consumption, in round numbers, as follows: In 1898, 108,000 bales; 1897, 180,000 bales; 1896, 101,000 bales; 1895, 210,000 bales; 1894, 227,000 bales.

FARMERS' BULLETINS.

The following is a list of the Farmers' Bulletins available for distribution, showing the number, title, and size in pages of each. Copies will be sent to any address on application to Senators, Representatives, and Delegates in Congress, or to the Secretary of Agriculture, Washington, D. C.:

16. Leguminous Plants. Pp. 24.
19. Important Insecticides. Pp. 32.
21. Barnyard Manure. Pp. 32.
22. The Feeding of Farm Animals. Pp 32.
23. Foods: Nutritive Value and Cost. Pp 32.
24. Hog Cholera and Swine Plague. Pp. 16.
25. Peanuts: Culture and Uses. Pp. 24.
26. Sweet Potatoes: Culture and Uses. Pp. 30.
27. Flax for Seed and Fiber. Pp. 16.
28. Weeds: And How to Kill Them. Pp. 32.
29. Souring and Other Changes in Milk. Pp. 23.
30. Grape Diseases on the Pacific Coast. Pp. 15.
31. Alfalfa, or Lucern. Pp. 24.
32. Silos and Silage. Pp. 32.
33. Peach Growing for Market. Pp. 24.
34. Meats: Composition and Cooking. Pp. 29.
35. Potato Culture. Pp. 24.
36. Cotton Seed and Its Products. Pp. 16.
37. Kafir Corn: Culture and Uses. Pp. 12.
38. Spraying for Fruit Diseases. Pp. 12.
39. Onion Culture. Pp. 31.
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41. Fowls: Care and Feeding. Pp. 24.
42. Facts About Milk. Pp. 29.
43. Sewage Disposal on the Farm. Pp. 20.
44. Commercial Fertilizers. Pp. 24.
45. Insects Injurious to Stored Grain. Pp. 24.
46. Irrigation in Humid Climates. Pp. 27.
47. Insects Affecting the Cotton Plant. Pp. 32.
48. The Manuring of Cotton. Pp. 16.
49. Sheep Feeding. Pp. 24.
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51. Standard Varieties of Chickens. Pp. 48.
52. The Sugar Beet. Pp. 48.
53. How to Grow Mushrooms. Pp. 20.
54. Some Common Birds. Pp. 40.
55. The Dairy Herd. Pp. 24.
56. Experiment Station Work—I. Pp. 31.
57. Butter Making on the Farm. Pp. 16.
58. The Soy Bean as a Forage Crop. Pp. 24.
59. Bee Keeping. Pp. 32.
60. Methods of Curing Tobacco. Pp. 16.
61. Asparagus Culture. Pp. 40.
62. Marketing Farm Produce. Pp. 28.
63. Care of Milk on the Farm. Pp. 40.
64. Ducks and Geese. Pp. 48.
65. Experiment Station Work—II. Pp. 32.
66. Meadows and Pastures. Pp. 28.
67. Forestry for Farmers. Pp. 48.
68. The Black Rot of the Cabbage. Pp. 22.
69. Experiment Station Work—III. Pp. 32.
70. Insect Enemies of the Grape. Pp 23.
71. Essentials in Beef Production. Pp. 24.
72. Cattle Ranges of the Southwest. Pp. 32.
73. Experiment Station Work—IV. Pp. 32.
74. Milk as Food. Pp. 39.
75. The Grain Smuts. Pp. 20.
76. Tomato Growing. Pp. 30.
77. The Liming of Soils. Pp. 19.
78. Experiment Station Work—V Pp. 32.
79. Experiment Station Work—VI. Pp. 28.
80. The Peach Twig-borer. Pp 16.
81 Corn Culture in the South. Pp 24.
82. The Culture of Tobacco. Pp. 24.
83. Tobacco Soils. Pp. 23.
84. Experiment Station Work—VII. Pp. 32.
85. Fish as Food. Pp. 30.
86. Thirty Poisonous Plants. Pp. 32.
87. Experiment Station Work—VIII. Pp. 32.
88. Alkali Lands. Pp. 23.
89. Cowpeas. Pp. 16.
90. The Manufacture of Sorghum Sirup. Pp. 32.
91. Potato Diseases and Their Treatment. Pp. 12.
92. Experiment Station Work—IX. Pp. 30.
93. Sugar as Food. Pp. 27
94. The Vegetable Garden. Pp 24.
95. Good Roads for Farmers. Pp. 47.
96. Raising Sheep for Mutton Pp. 48.
97. Experiment Station Work—X. Pp. 32.
98. Suggestions to Southern Farmers. Pp. 48.
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102. Southern Forage Plants. Pp 48
103. Experiment Station Work—XI. Pp. 32.
104. Notes on Frost. Pp. 24.
105. Experiment Station Work—XII Pp. 32.
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114. Experiment Station Work—XIV. Pp. 28.
115. Hop Culture in California Pp. 28.
116. Irrigation in Fruit Growing Pp. 48.
117. Sheep, Hogs, and Horses in the Northwest. Pp. 28.
118. Grape Growing in the South. Pp. 32.

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